

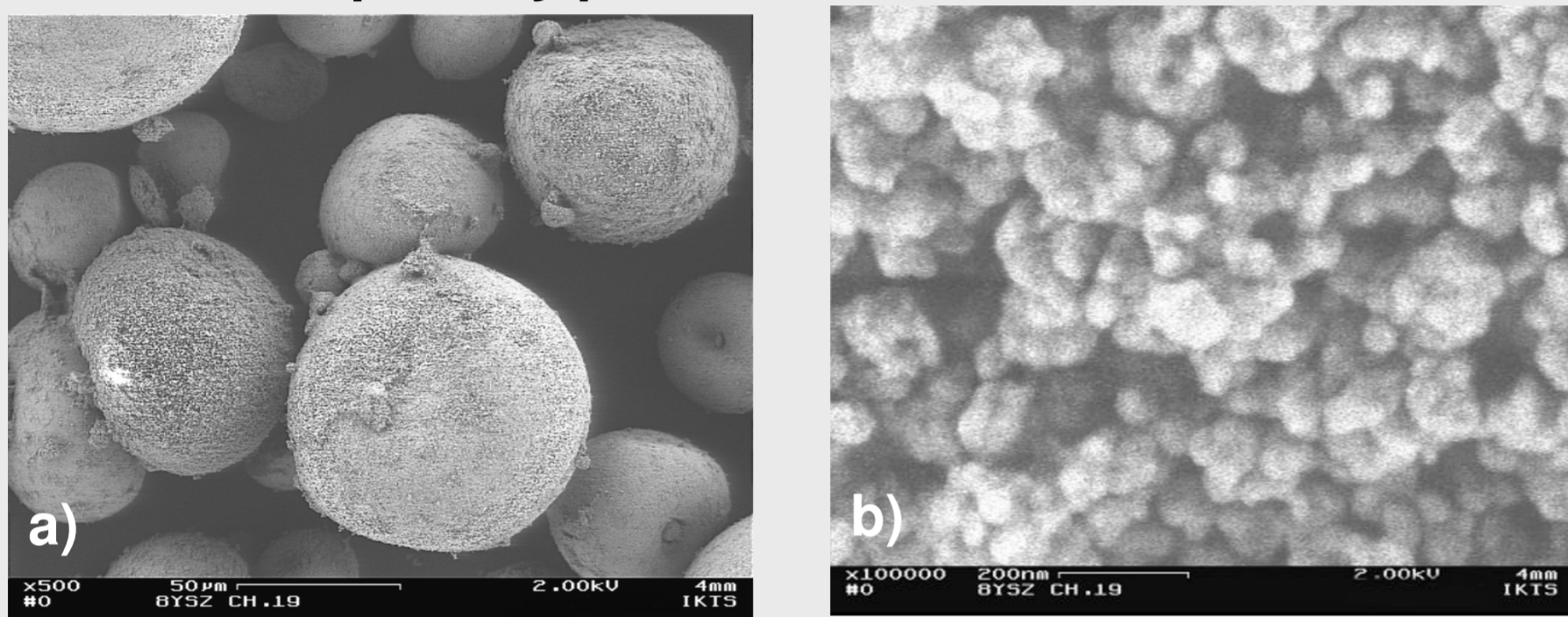
## Objectives

### Investigation of zirconia nanoparticles:

- Influence of different dispersants on deagglomeration
- Properties of screen printing pastes
- Properties of sintered layers and practical application

## Materials and Manufacturing

- 8YSZ (Fa. Tosoh)
  - Spherical high agglomerated  $ZrO_2$ - particles
  - Size of agglomerates ~ 20-50  $\mu m$
  - Size of primary particle ~ 20-30 nm



8YSZ agglomerates (a) and nano-sized primary particles (b)

### Dispersants

- amphoteric dispersant TS
- amphoteric dispersant TT
- amphoteric dispersant TB
- Preparation
  - wet milling with dispersants in a planetary ball mill [A]
  - high shear mixing three roll mill [B]



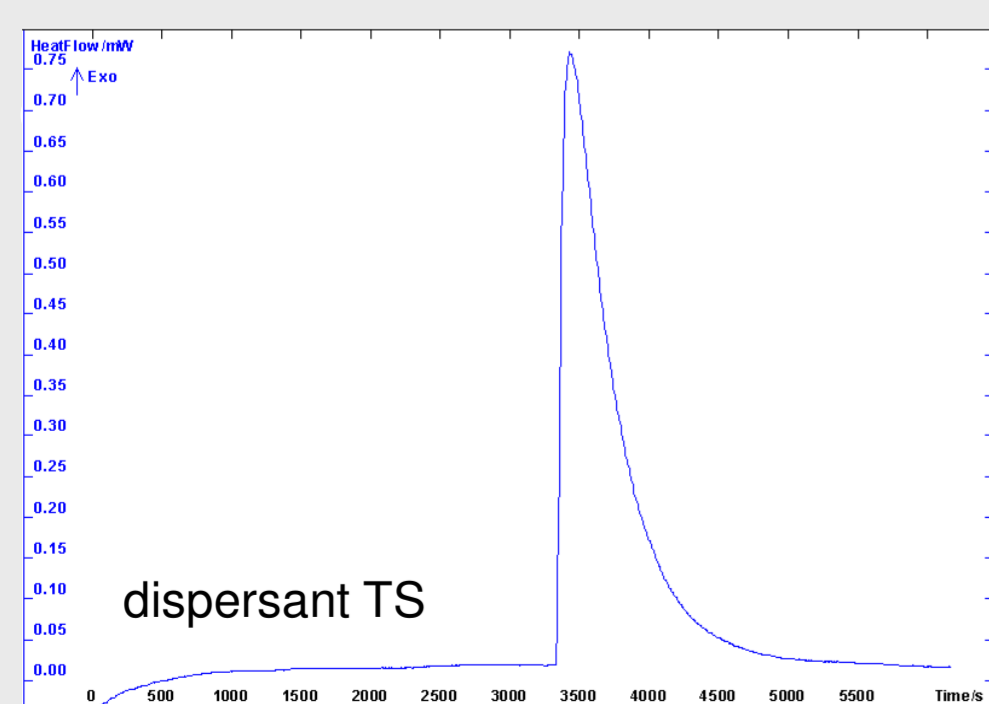
## Choice of dispersants – calorimetric investigations



### Calorimetric measurements with SETARAM C80:

#### Observed effects of

- Water desorption, which depends from used solvent
- Heat of mixtures

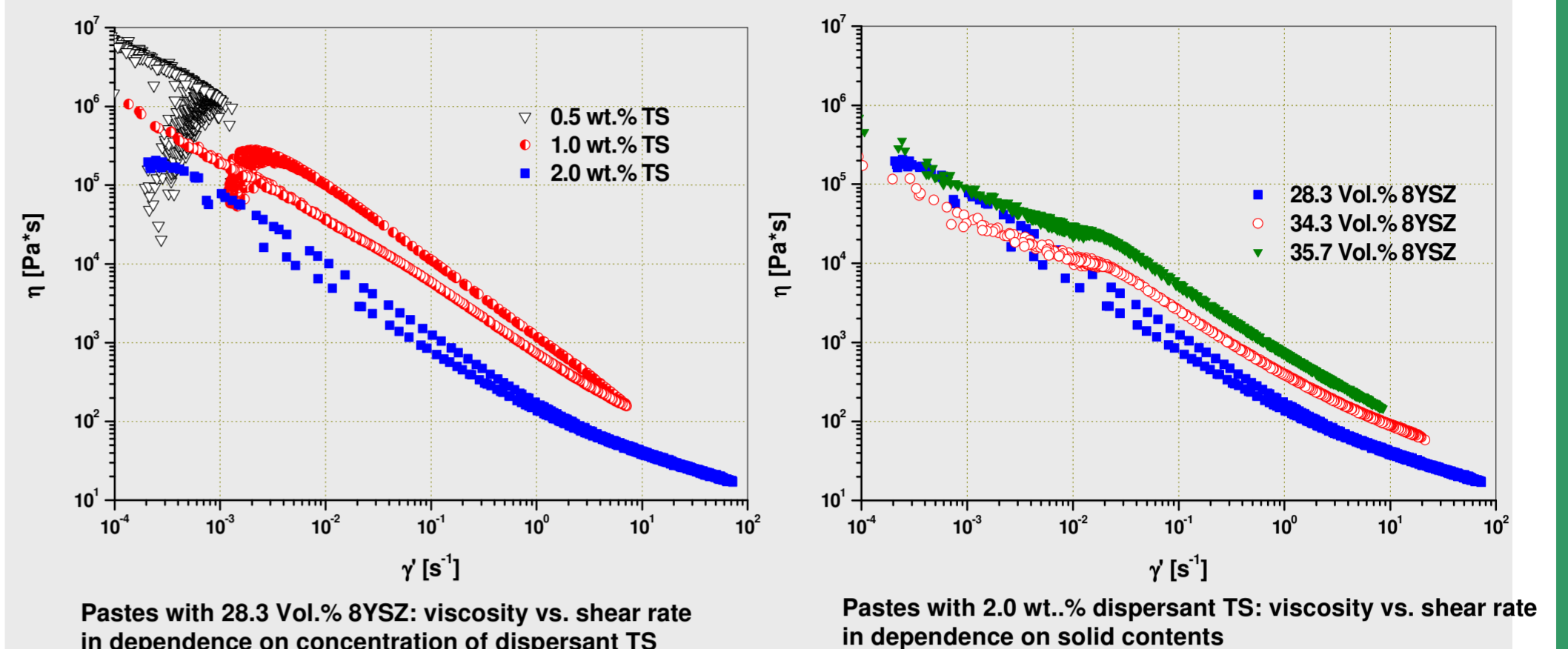


#### Adsorption enthalpy for different dispersants:

Dispersant TS	-1.25 J/g
Dispersant TT	-0.47 J/g
Dispersant TB	-0.43 J/g

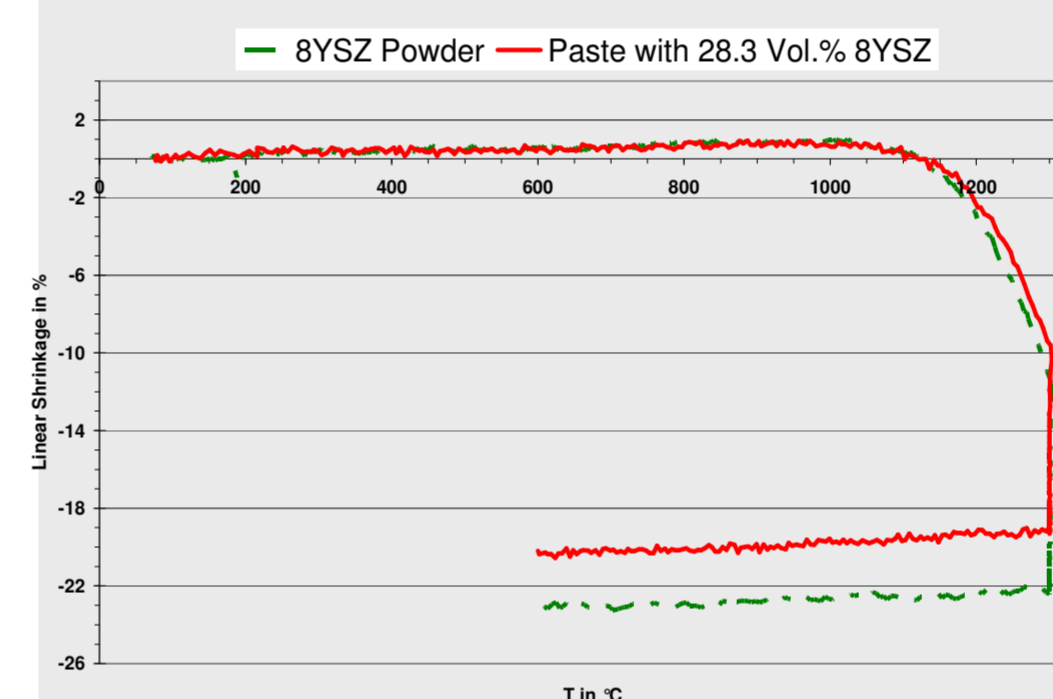
- Milling or high shear mixing with optimal dispersants improves dispersibility of zirconia
- Best results with dispersant TS

## Rheological Analysis



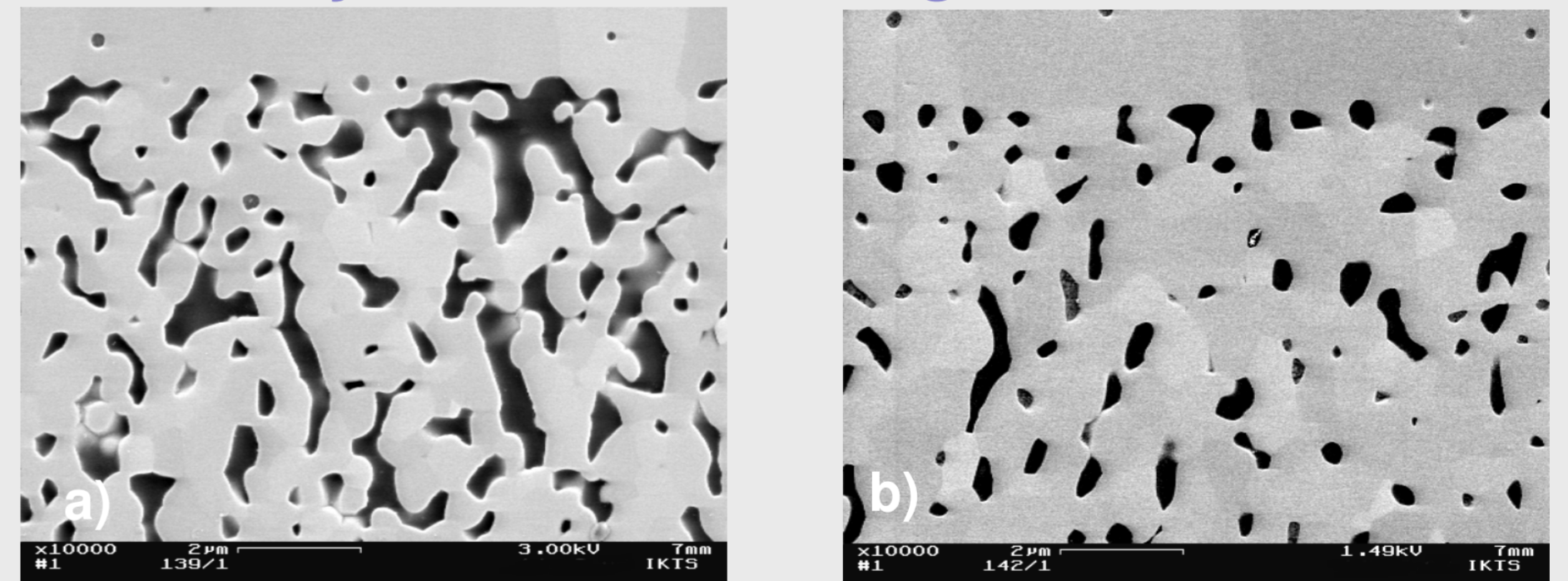
- Viscosity decreases with increasing dispersant concentration
- Screen printing pastes with high solid contents (up to 36vol.% 8YSZ) can be realized reproducibly and effectively with roller mill
- Pastes are long-time stable
- Control of viscosity important for applications (e.g. screen printing)

## Shrinkage Tests



- Pastes with a high solid content are preferred for minimized shrinkage during drying and sintering
- Paste with 28.3 vol.% 8YSZ, which was prepared using dispersant TS on the three roll mill, shows lower shrinkage in comparison with 8YSZ powder

## Sintered layers – SEM investigation



Scanning electron micrograph of sintered at 1300 °C pastes with 28.3 vol.% 8YSZ (a) and 35.7 vol.% 8YSZ (b)

- Significant decrease in porosity for pastes with high solid contents
- Highest densification for paste with 35.7 vol.% 8YSZ
- Lower sintering temperatures can be achieved when nano-sized powders are used
- Optimized dispersion leads to improved screen printing properties

## Summary

- Effective dispersion of nano-sized 8YSZ using optimal dispersant and wet milling
- Application of dispersant enables
  - control of viscosity
  - improved deagglomeration
  - pastes with higher solid contents
- Preparation of pastes with three roll mill allows high solid contents, effective production and reproducible paste properties
- Porosity of sintered layers was significantly improved